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# THE NEW VITALISM

BY JOHN BURROUGHS

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IF one attempts to reach any rational conclusion on the question which the president of the British Association for the Advancement of Science discussed at the last meeting of that body—namely, the question of the nature and origin of life on this planet—he soon finds himself in close quarters with two difficulties. He must either admit of a break in the course of nature and the introduction of a new principle, the vital principle, which, if he is a man of science, he finds it hard to do; or he must accept the theory of the physico-chemical origin of life, which, as a being with a soul, he finds it equally hard to do. In other words, he must either draw an arbitrary line between the inorganic and the organic when he knows that arbitrary lines in nature, and fencing off one part from another, is an unscientific procedure, and one that often leads to bewildering contradictions; or he must look upon himself with all his high thoughts and aspirations, and upon all other manifestations of life, as merely a chance product of the blind mechanical and chemical action and interaction of the inorganic forces.

Either conclusion is distasteful. One does not like to think of himself as a chance hit of the irrational physical elements, as Professor Loeb apparently does;\* neither does he feel at ease with the thought that he is the result of any break or discontinuity in natural law. He likes to see himself as vitally and inevitably related to the physical order, as is the fruit to the tree that bore it, or the child to the mother that carried it in her womb, and yet, if only mechanical and chemical forces entered into his genesis, he does not feel himself well fathered and authenticated.

One may evade the difficulty, as Helmholtz did, by regarding life as eternal—that it had no beginning in time; or, as

\* See *The Mechanistic Conception of Life*.

some other German biologists have done, that the entire cosmos is alive and the earth a living organism.

If biogenesis is true, and always has been true—no life without antecedent life—then the question of a beginning is unthinkable. It is just as easy to think of a stick with only one end.

Such stanch materialists and mechanists as Haeckel and Verworn seem to have felt compelled, as a last resort, to postulate a psychic principle in nature, though of a low order. Haeckel says that most chemists and physicists will not hear a word about a "soul" in the atom. "In my opinion, however," he says, "in order to explain the simplest physical and chemical processes, we must necessarily assume a low order of psychical activity among the homogeneous particles of plasm, rising a very little above that of the crystal." In crystallization he sees a low degree of sensation and a little higher degree in the plasm.

Have we not in this rudimentary psychic principle which Haeckel ascribes to the atom a germ to start with that will ultimately give us the mind of man? With this spark, it seems to me, we can kindle a flame that will consume Haeckel's whole mechanical theory of creation. Physical science is clear that the non-living or inorganic world was before the living or organic world, but that the latter in some mysterious way lay folded in the former. Science has for many years been making desperate efforts to awaken this slumbering life in its laboratories, but has not yet succeeded, and probably never will succeed. Life without antecedent life seems a biological impossibility. The theory of spontaneous generation is rejected by the philosophical mind, because our experience tells us that everything has its antecedent, and there is and can be no end to the causal sequences.

Spencer believes that the organic and inorganic fade into each other by insensible gradations—that no line can be drawn between them so that one can say, on this side is the organic, on that the inorganic. In other words, he says it is not necessary for us to think of an absolute commencement of organic life, or of a first organism—organic matter was not produced all at once, but was reached through steps or gradations. Yet it puzzles one to see how there can be any gradations or degrees between being and not-being. Can there be any half-way house between something and nothing?

There is another way out of the difficulty that besets our rational faculties in their efforts to solve this question, and that is the audacious way of Henri Bergson in his *Creative Evolution*. It is to deny any validity to the conclusion of our logical faculties upon this subject. Our intellect, Bergson says, cannot grasp the true nature of life, nor the meaning of the evolutionary movement. With the emphasis of italics he repeats that "*the intellect is characterized by a natural inability to comprehend life.*" He says this in a good many pages and in a good many different ways; the idea is one of the main theories of his book. Our intuitions, our spiritual nature, according to this philosopher, are more *en rapport* with the secrets of the creative energy than are our intellectual faculties; the key to the problem is to be found here, and not in the mechanics and chemistry of the latter. Our intellectual faculties can grasp the physical order because they are formed by a world of solids and fluids and give us the power to deal with them and act upon them. But they cannot grasp the nature and the meaning of the vital order.

"We treat the living like the lifeless, and think all reality, however fluid, under the form of the sharply defined solid. We are at ease only in the discontinuous, in the immobile, in the dead. Perceiving in an organism only parts external to parts, the understanding has the choice between two systems of explanation only: either to regard the infinitely complex (and thereby infinitely well contrived) organization as a fortuitous concatenation of atoms or to relate it to the incomprehensible influence of an external force that has grouped its elements together."

"Everything is obscure in the idea of creation, if we think of things which are created and a thing which creates." If we follow the lead of our logical, scientific faculties, then, we shall all be mechanists and materialists. Science can make no other solution of the problem because it sees from the outside. But if we look from the inside, with the spirit or "with that faculty of seeing which is immanent in the faculty of acting," we shall escape from the bondage of the mechanistic view into the freedom of the larger truth of the ceaseless creative view; we shall see the unity of the creative impulse which is immanent in life and which, "passing through generations, links individuals with individuals, species with species, and makes of the whole series of the living one single immense wave flowing over matter."

I recall that Tyndall, who was as much poet as scientist,

speaks of life as a wave "which at no two consecutive moments of its existence is composed of the same particles." In his more sober scientific mood Tyndall would doubtless have rejected M. Bergson's view of life, but his image of the wave is very Bergsonian. But what different meanings the two writers aim to convey: Tyndall is thinking of the fact that a living body is constantly taking up new material on the one side and dropping dead or outworn material on the other. M. Bergson's mind is occupied with the thought of the primal push or impulsion of matter which travels through it as the force in the wave traverses the water. The wave embodies a force which lifts the water up in opposition to its tendency to seek and keep a level, and travels on, leaving the water behind. So does this something we call life break the deadlock of inert matter and lift it into a thousand curious and beautiful forms, and then, passing on, lets it fall back again into a state of dead equilibrium.

Tyndall was one of the most eloquent exponents of the materialistic theory of the origin of life, and were he living now would probably feel little or no sympathy with the Bergsonian view of a primordial life impulse. He found the key to all life phenomena in the hidden world of molecular attraction and repulsion. He says:

"Molecular forces determine the form which the solar energy will assume. [What a world of mystery lies in that determinism of the hidden molecular forces!] In the separation of the carbon and oxygen this energy may be so conditioned as to result in one case in the formation of a cabbage and in another case in the formation of an oak. So also as regards the reunion of the carbon and the oxygen [in the animal organism], the molecular machinery through which the combining energy acts may in one case weave the texture of a frog, while in another it may weave the texture of a man."

But is not this molecular force itself a form of solar energy, and can it differ in kind from any other form of physical force? If molecular forces determine whether the solar energy shall weave a head of a cabbage or a head of a Plato or a Shakespeare, does it not meet all the requirements of our conception of creative will?

Tyndall thinks that a living man — Socrates, Aristotle, Goethe, Darwin, I suppose — could be produced directly from inorganic nature in the laboratory if (and note what a momentous "if" this is) we could put together the elements of such a man in the same relative positions as those

which they occupy in his body, "with the selfsame forces and distribution of forces, the selfsame motions and distribution of motions." Do this, and you have a St. Paul or a Luther or a Lincoln. Dr. Verworn said essentially the same thing in a lecture before one of our colleges while in this country last year—easy enough to manufacture a living being of any order of intellect if you can reproduce in the laboratory his "internal and external *vital conditions*." (The italics are mine.) Those vital conditions—"the mystery and the miracle of vitality" is where the rub comes. Those vital conditions, as regards the minutest bit of protoplasm, science, with all her tremendous resources, has not yet been able to produce. The raising of Lazarus from the dead seems no more a miracle than evoking these vital conditions in dead matter. External and internal vital conditions are no doubt inseparably correlated, and when we can produce them we shall have life. Life, says Verworn, is like fire, and "is a phenomenon of nature which appears as soon as the complex of its conditions is fulfilled." We can easily produce fire by mechanical and chemical means, but not life. Fire is a chemical process, it is rapid oxidation, and oxidation is a disintegrating process, while life is an integrating process, or a balance maintained between the two by what we call the vital force. Life is evidently a much higher form of molecular activity than combustion. The old Greek Heraclitus saw, and the modern scientist sees, very superficially in comparing the two.

I have no doubt that Huxley was right in his inference "that if the properties of matter result from the nature and disposition of its component molecules, then there is no intelligible ground for refusing to say that the properties of protoplasm result from the nature and disposition of its molecules." It is undoubtedly in that nature and disposition of the biological molecules that the whole "mystery and miracle of vitality" is wrapped up. If we could only grasp what it is that transforms the molecule of dead matter into the living molecule! Pasteur called it "dissymmetric force," which is only a new name for the mystery. He believed there was an "irrefragable physical barrier between organic and inorganic nature"—that the molecules of an organism differed from those of a mineral, and for this difference he found a name.

There seems to have been of late years a marked reaction, even among men of science, from the mechanistic conception of life as held by the band of scientists to which I have referred. Something like a new vitalism is making headway both on the Continent and in Great Britain. This neo-vitalism has found a forceful expounder in Professor Arthur Thompson, of Aberdeen University, who has recently written convincingly in favor of this view in the *Hibbert Journal*. Professor Bunge, Dr. Haldane, Dr. Driesch, whom he quotes, urge that biological problems "defy any attempt at a mechanical explanation." These men stand for the idea "of the creative individuality of organisms" and that the main factors in organic evolution cannot be accounted for by the forces already operative in the inorganic world. What standing the new vitalism has among the scientific men of this country I have little means of knowing. Judging from the attitude of Professor Loeb on the subject, one would say it had none at all. If I understand Professor Loeb, he urges that the origin of life was a mere chance hit on the part of nature—an accident in the blind clashing and jostling of the physical forces—as much so, I fancy he would say, as the carving out of a natural bridge by the action of water upon the rocks was accidental; the bridge might easily have failed; indeed, has failed in innumerable instances; and life, according to this theory, must have missed it any number of times.

There is, of course, a mathematical chance that in the endless changes and permutations of inert matter the four principal elements that make up a living body may fall or run together in just that order and number that the kindling of the flame of life requires, but it is a disquieting proposition. One atom too much or too little of any of them—three of oxygen where two were required, or two of nitrogen where only one was wanted—and the face of the world might have been vastly different. Not only did much depend on their coming together, but upon the order of their coming; they must unite in just such an order. Insinuate an atom or corpuscle of hydrogen or carbon at the wrong point in the ranks, and the trick is a failure.

When we regard all the phenomena of life and the spell it seems to put upon inert matter, so that it behaves so differently from the same matter before it is drawn into the life circuit, how it lifts up a world of dead particles out of the

soil against gravity into trees and animals; how it changes the face of the earth; how it comes and goes while matter stays; how it defies chemistry and physics to evoke it from the non-living; how its departure, or cessation, lets the matter fall back to the inorganic—when we consider these and others like them we seem compelled to think of life as something, some force or principle in itself, as M. Bergson does, existing apart from the matter it animates. As Sir Oliver Lodge does also. We may class Sir Oliver among the neo-vitalists from a remark he is reported to have made recently about

“the thing which by interaction with matter confers on it what we know as vitality. . . . It does not appear to be a form of energy, but certainly is a guiding principle, utilizing the forces known to chemistry and physics and all the ordinary laws of nature for ends which appear to lie outside the known laws of the physical world.”

Sir Oliver, famous physicist that he is, yet has a vein of mysticism and idealism in him which sometimes makes him recoil from the hard-and-fast interpretations of natural phenomena by physical science. Like M. Bergson, he sees in life some tendency or impetus which arose in matter at a definite time and place, “and which has continued to interact with and incarnate itself in matter ever since.”

If a living body is a machine, then we behold a new kind of machine with new kinds of mechanical principles—a machine that repairs itself, that reproduces itself, a clock that winds itself up, an engine that stokes itself, a gun that aims itself, a machine that divides and makes two, two unite and make four, a million or more unite and make a man or a tree—a machine that is nine-tenths water, a machine that feeds on other machines; in fact, a machine that does all sorts of unmechanical things and that no known combination of mechanical and chemical principles can reproduce—a vital machine. The idea of the vital as something different from and opposed to the mechanical must come in. Something had to be added to the mechanical and chemical to make the vital.

Spencer explains in terms of physics why an ox is larger than a sheep, but he throws no light upon the subject of the individuality of these animals—what it is that makes an ox an ox or a sheep a sheep. These animals are built up out of the same elements by the same processes, and they may both have had the same stem form in remote biologic time.



If so, what made them diverge and develop into such totally different forms? After the living body is once launched, many, if not all, of its operations and economies can be explained on principles of mechanics and chemistry, but the something that avails itself of these principles and develops an ox in the one case and a sheep in the other—what of that?

Spencer is forced into using the term “amount of vital capital.” How much more of it some men, some animals, some plants have than others! What is it? What did Spencer mean by it? This capital augments from youth to manhood, and then after a short or long state of equilibrium slowly declines to the vanishing-point.

Again, what a man does depends upon what he is, and what he is depends upon what he does. Structure determines function, and function reacts upon structure. This interaction goes on throughout life; cause and effect interchange or play into each other's hands. The more power we spend within limits the more power we have. This is another respect in which life is utterly unmechanical. A machine does not grow stronger by use as our muscles do; it does not store up or conserve the energy it expends. The gun is weaker by every ball it hurls; not so the baseball pitcher; he is made stronger up to the limit of his capacity for strength.

It is plain enough that all living beings are machines in this respect—they are kept going by the reactions between their interior and their exterior; these reactions are either mechanical, as in flying, swimming, walking, and involve gravitation, or they are chemical and assimilative, as in breathing and eating. To that extent all living things are machines—some force exterior to themselves must aid in keeping them going; there is no spontaneous or uncaused movement in them; and yet what a difference between a machine and a living thing!

True it is that a man cannot live and function without heat and oxygen, nor long without food, and yet his relation to his medium and environment is as radically different from that of the steam-engine as it is possible to express. His driving-wheel, the heart, acts in response to some stimulus as truly as does the piston of the engine, and the principles involved in circulation are all mechanical; and yet the main thing is not mechanical, but vital. Analyze the vital activi-

ties into principles of mechanics and of chemistry, if you will, yet there is something involved that is neither mechanical nor chemical, though it may be that only the imagination can grasp it.

The type that prints the book is set up and again distributed by a purely mechanical process, but that which the printed page signifies involves something not mechanical. The mechanical and chemical principles operative in men's bodies are all the same; the cell structure is the same, and yet behold the difference between men in size, in strength, in appearance, in temperament, in disposition, in capacities! All the processes of respiration, circulation, and nutrition in our bodies involve well-known mechanical principles, and the body is accurately described as a machine; and yet, if there were not something in it that transcends mechanics and chemistry, would you and I be here? A machine is the same whether it is in action or repose, but when a body ceases to live—that is, to function—it is not the same. It cannot be set going like a machine; the motor power has ceased to be. But if the life of the body were no more than the sum of the reactions existing between the body and the medium in which it lives, this were not so. A body lives as long as there is a proper renewal of the interior medium through exchanges with its environment.

Mechanical principles are operative in every part of the body—in the heart, in the arteries, in the limbs, in the joints, in the bowels, in the muscles; and chemical principles are operative in the lungs, in the stomach, in the liver, in the kidneys; but to all these things do we not have to add something that is not mechanical or chemical to make the man, to make the plant? A higher mechanics, a higher chemistry, if you prefer, a force, but a force differing in kind from the physical forces.

The forces of life are constructive forces, and work in a world of disintegrating or destructive forces which oppose them and which they overcome. The mechanical and the chemical forces of dead matter are the enemies of the forces of life till life overcomes and uses them; as much so as gravity, fire, frost, water are man's enemies till he has learned how to subdue and use them.

It is a significant fact that the four chief elements which in various combinations make up living bodies are by their extreme mobility well suited to their purpose. Three of

these are gaseous; only the carbon is a solid. This renders them facile and adaptive in the ever-changing conditions of organic evolution. The solid carbon forms the vessel in which the precious essence of life is carried. Without carbon we should evaporate or flow away and escape. Much of the oxygen and hydrogen enters into living bodies as water; nine-tenths of the human body is water; a little nitrogen and a few mineral salts make up the rest. So that our life in its final elements is little more than a stream of water holding in solution carbonaceous and other matter, and flowing, forever flowing, a stream of fluid and solid matter plus something else that scientific analysis cannot reach—some force or principle that combines and organizes these elements into the living body.

If a man could be reduced instantly into his constituent elements, we should see a pail or two of turbid fluid that would flow down the bank and soon be lost in the soil. That which gives us our form and stability and prevents us from slowly spilling down the slope at all times is the mysterious vital principle or force which knits and marries these unstable elements together and raises up a mobile but more or less stable form out of the world of fluids. Venus rising from the sea is a symbol of the genesis of every living thing.

Inorganic matter seeks only rest. "Let me alone," it says; "do not break my slumbers." But as soon as life awakens in it, it says: "Give me room, get out of my way. Ceaseless activity, ceaseless change, a thousand new forms is what I crave." As soon as life enters matter, matter meets with a change of heart. It is lifted to another plane, the supermechanical plane; it behaves in a new way; from its movements being calculable they become incalculable. A straight line has direction, that is mechanics; what direction has the circle? That is life, a change of direction every instant. Life includes the mechanical and the chemical, but they do not include it. An aeroplane is built entirely on mechanical principles, but something not so built has to sit in it and guide it; in fact, had to build it and adjust it to its end.

Mechanical forces seek an equilibrium or a state of rest. The whole inorganic world under the influence of gravity would flow as water flows, if it could, till it reached a state of absolute repose. But vital forces struggle against a state of repose, which to them means death. They are vital

by virtue of their tendency to resist the repose of inert matter; chemical activity disintegrates a stone or other metal, but the decay of organized matter is different in kind; living organisms decompose it and resolve it into its original compounds.

Vital connections and mechanical connections differ in kind. You can treat mechanical principles mathematically, but can you treat life mathematically? Will your formulas and equations apply here? You can figure out the eclipse of the sun and moon for centuries to come, but who can figure out the eclipses of nations or the overthrow of parties or the failures of great men? And it is not simply because the problem is so vastly more complex; it is because you are in a world where mathematical principles do not apply. Mechanical forces will determine the place and shape of every particle of inert matter any number of years or centuries hence, but they will not determine the place and condition of matter imbued with the principle of life.

We can graft living matter, we can even graft a part of one animal's body into another animal's body, but the mechanical union which we bring about must be changed into a vital union to be a success, the spirit of the body has to second our efforts. The same in grafting a tree or anything else, the mechanical union which we effect must become a vital union; and this will not take place without some degree of consanguinity, the live scion must be recognized and adapted by the stock in which we introduce it.

Living matter may be symbolized by a stream; it is ever and never the same; life is a constant becoming; our minds and our bodies are never the same at any two moments of time; life is ceaseless change. A machine is static, life is dynamic; it uses all mechanical and chemical principles, but it never rests with them, and is not summed up by them.

No doubt it is between the stable and the unstable condition of the molecules of matter that life is born. The static condition to which all things tend is death. Matter in an unstable condition tends either to explode or to grow or to disintegrate. So that an explosion bears some analogy to life, only it is quickly over and the static state of the elements is restored. Life is an infinitely slower explosion, or a prolonged explosion, during which some matter of the organism is being constantly burned up, and thus returned to a state of inorganic repose, while new matter is taken

in and kindled and consumed by the fires of life. One can visualize all this and make it tangible to the intellect. Get your fire of life started and all is easy, but how to start it is the rub. Get your explosive compound, and something must break the deadlock of the elements before it will explode. So in life, what is it that sets up this slow, gentle explosion that makes the machinery of our vital economies go? That draws new matter into the vortex and casts the used-up material out—in short, that creates and keeps up the unstable condition, the seesaw upon which life depends? To enable the mind to grasp it we have to invent or posit some principle, call it the vital force, as so many have done and still do, or call it molecular force, as Tyndall does, or the power of God, as our orthodox brethren do, it matters not. We are on the border-land between the knowable and the unknowable, where the mind can take no further step. There is no life without carbon and oxygen, hydrogen and nitrogen, but there is a world of these elements without life. What must be added to them to set up the reaction we call life? Nothing that chemistry can disclose.

New tendencies and activities are set up among these elements, but the elements themselves are not changed; oxygen is still oxygen and carbon still carbon, yet behold the wonder of their new workmanship under the tutelage of life! Yet life is not a thing. It is our name for a tendency, a condition of matter—matter held in leash by something and striving to get free and return to the repose of the inorganic.

Life only appears when the stable passes into the unstable, yet this change takes place all about us in our laboratories, and no life appears. We can send an electric spark through a room full of oxygen and hydrogen gas, and with a tremendous explosion we have water—an element of life, but not life.

Some of the elements seem nearer life than others. Water is near life; heat, light, the colloid state are near life; osmosis, oxidation, chemical reactions are near life; the ashes of inorganic bodies are nearer life than the same minerals in the rocks and soil, but none of these things is life.

We may follow life down to the ground—yes, under the ground, into the very roots of matter and motion—yea, beyond the roots, into the imaginary world of molecules and atoms, and their attractions and repulsions—and not find its secret. Indeed, science—the new science—pursues

matter to the vanishing-point, where it ceases to become matter and becomes pure force or spirit. What takes place in that imaginary world where ponderable matter ends and becomes disembodied force, and where the hypothetical atoms are no longer divisible, we may conjecture but may never know. We may fancy the infinitely little going through a cycle of evolution like that of the infinitely great, and solar systems developing and revolving inside of the ultimate atoms, but the Copernicus or the Laplace of the atomic astronomy has not yet appeared. The atom itself is an invention of science. To get the mystery of vitality reduced to the atom is getting it in very close quarters, but it is a very big mystery still. Just how the dead becomes alive, even in the atom, is mystery enough to stagger any scientific mind. It is not the volume of the change; it is the quality or kind. Chemistry and mechanics we have always known, and they always remain chemistry and mechanics. They go into our laboratories and through our devices chemistry and mechanics, and they come out chemistry and mechanics. They will never come out life, conjure with them as we will, and we can get no other result. We cannot inaugurate the mystic dance among the atoms that will give us the least throb of life.

The psychic arises out of the organic, and the organic arises out of the inorganic, and the inorganic arises out of—what? The relation of each to the other is as intimate as that of the soul to the body; we cannot get between them even in thought, but the difference is one of kind and not of degree. The vital transcends the mechanical, and the psychic transcends the vital—is on another plane, and yet without the sun's energy there could be neither. Thus are things knit together, thus does one thing flow out of or bloom out of another. We date from the rocks, and the rocks date from the fiery nebulae, and the loom in which the texture of our lives was woven is the great loom of vital energy about us and in us; but what hand guided the shuttle and invented the pattern—who knows?

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